Report of Proceedings

RESEARCH CONFERENCE ON CHEESE

October 30 and 31, 1957

Beltsville, Maryland

Conference was held by the Eastern Utilization Research and Development Division with representatives from industry, the State Agricultural Experiment Stations, universities, cheese manufacturers, the U. S. Department of Agriculture, and the Food and Drug Administration.

Eastern Utilization Research and Development Division
Agricultural Research Service
United States Department of Agriculture
Philadelphia 18, Pennsylvania

This report summarizes the discussions of the various speakers during the conference. The complete presentations will be published in the Journal of Dairy Science. If further details regarding any particular subject are desired, they may be obtained by communicating with the person concerned (see appended list of names and addresses).

The group photograph which was taken at noon on Wednesday did not come out satisfactorily. Therefore, we regret that copies will not be available for distribution.

PROGRAM

Auditorium, Plant Industry Station,
Beltsville, Maryland

Wednesday, October 30

9:45 a.m.	Introductory Remarks	P. A. Wells, Director Eastern Utilization Research and Development Division
10:00 a.m.	Functions of the Food and Drug Administration and U. S. Department of Agriculture in Relation to Definitions, Standards, and Grades of Cheese	L. M. Beacham, Jr., Food and Drug Administration E. Small, Dairy Division, Agricultural Marketing Service
10:45 a.m.	New Developments in the Propagation of Starters: New Equipment and Plant Practices	M. W. Hales, Chr. Hansen's Laboratory, Milwaukee, Wisconsin
	New Developments in the Propagation of Starters: Culture Media and Phage Inhibition	F. J. Babel, Purdue University, Lafayette, Indiana
11:30 a.m.	Recent Research on Starter Failures: The Problem	R. P. Tittsler, Eastern Utilization Research and Development Division
	Recent Research on Starter Failures: Progress Report	R. L. Winslow, W. K. Moseley Laboratory, Indianapolis, Indiana
12:30 p.m.	Group Photograph (See Page ii)	
12:35 p.m.	LUNCH	
2:00 p.m.	Treatment of Milk for Cheese with Hydrogen Peroxide	Z. D. Roundy, Armour and Company, Chicago, Illinois
2:45 p.m.	Problems in the Soft, Italian-Type Cheese Industry	F. V. Kosikowski, Cornell University, Ithaca, New York
3:30 p.m.	The Manufacture of High Quality Cottage Cheese	M. E. Powell, Knudsen Creamery Company, Los Angeles, California

Thursday, October 31

9:30 a.m.	Labor-Saving Methods for Making Cheddar Cheese	H. E. Walter, Eastern Utilization Research and Development Division
10:20 a.m.	Utilization of Whey in Food Products	C. A. Alesch, Western Condensing Company, Appleton, Wisconsin
11:20 a.m.	Chemistry of Cheese Flavors	W. J. Harper, Ohio State University, Columbus, Ohio
12:30 p.m.	LUNCH	

Dairy Products Building,
Agricultural Research Center,
Beltsville, Maryland

2:00 p.m. to 4:00 p.m.	Demonstration of Labor-Saving Method for Making Cheddar Cheese	H. E. Walter, A. M. Sadler, and C. D. Mitchell, Eastern Utilization Research and Development Division

INTRODUCTORY REMARKS

by

P. A. Wells, Eastern Utilization Research and Development Division

Dr. Wells welcomed the delegates to the conference and expressed appreciation to the State agencies and the cheese industry for their fine support of the conference.

He explained that the Cheese Conference had its origin in discussions held last March with the Experiment Station Directors in the Eastern Region. Basically the conference was organized as a meeting of the Experiment Station Collaborators in the Eastern Area but in line with the practice of former years attendance was enlarged to include representatives from other Federal and State agencies as well as industry. Dr. Wells pointed out that the series of Collaborator conferences had been started in 1947 and has included a wide variety of commodity topics, among them being milk concentrates, tobacco, potatoes, maple products, and fruits and vegetables. Some of these conferences have been continued on an annual basis under various auspices. He expressed the hope that there would be sufficient interest to make future conferences on cheese worthwhile.

He pointed out that each of the conferees would receive one copy of the proceedings to be published. Additional copies of the proceedings would be made available on request.

FUNCTIONS OF THE FOOD AND DRUG ADMINISTRATION IN RELATION TO DEFINITIONS, STANDARDS, AND GRADES OF CHEESE

by

L. M. Beacham, Jr., Food and Drug Administration

The authority for promulgating standards of identity, quality, and fill of container under Section 401 of the Food, Drug, and Cosmetic Act and the nature of such standards are discussed. Guiding principles as they have been set forth in interpretative regulations are then explained, dealing with such matters as required and optional ingredients, and proper use of the names of standardized foods upon their labels.

Next is given a brief description of the procedure followed in establishing food standards under the Hale Amendment to the Act, and then the procedure followed when the proceedings require a public hearing.

Sixty standards applicable to cheese, cheese foods, cheese spreads, and other standardized cheese products have been established up to the present. These can be found in Code of Federal Regulations, Title 21, Chapter 1, part 19.

Important revisions in the cheese standards since 1955 are cited. The most notable of these is permission to use not more than 0.2% sorbic acid

on certain cheeses in the form of slices or cuts in consumer-size packages with the label statement "Sorbic acid added to retard mold growth" or "Sorbic acid added as a preservative." The cheeses where this is permitted are: Cheddar, washed curd, colby, granular, swiss, provolone, asiago fresh, semisoft part-skim, pasteurized process pimento cheese, pasteurized process cheese spread, gruyere, brick, muenster, monterey, high-moisture jack, caciocavallo siciliano, semisoft cheeses, pasteurized process cheese, and pasteurized process cheese food.

Sodium or calcium propionate, or both, may also be used in concentrations up to 0.3% in pasteurized process cheese, pasteurized process pimento cheese, pasteurized process cheese food, and pasteurized process cheese spread. A label statement similar to the above must be used.

A discussion follows of recent proposals for new cheese standards, e.g., ricotta, part-skim ricotta, samsoe, mozzarella, part-skim mozzarella, grated American cheese food, partially creamed cottage cheese, and nuworld cheese. The latter is the only one of these for which a standard of identity has become effective. It is a blue-mold type of cheese but is made with a white-mold mutant developed by X-ray exposure of blue mold. The petition for a standard for partially creamed cottage cheese has been denied after public hearings. The proposal was for a cottage cheese with other added dairy ingredients to give a product having between 0.5 and 2.0% fat. At a hearing the testimony showed that many persons could not clearly distinguish the product from plain cottage cheese or from creamed cottage cheese with 4% fat. A standard for such a product did not appear likely to promote honesty or fair dealing in the interest of consumers.

The remaining proposals for standards for cheese and cheese products are still under consideration and may require public hearings. The standards for ricotta and part-skim ricotta have been stayed because of objections from certain importers that the name ricotta properly belongs to an imported whey cheese. Those for mozzarella and part-skim mozzarella have not become effective because of objections by interested parties that the moisture limit is too low. The proposed standard for samsoe has been stayed because of objections of packers of domestic swiss cheese, who feel that because samsoe resembles swiss cheese so closely it should have the same moisture and fat limits, i.e., 41% and 43%, respectively. In the case of grated American cheese food, the published standard has been stayed because of objections from Kraft Foods, Western Condensing Co., and Foremost Dairies to the failure of the standard to list dried whey as a permitted ingredient, and objections on the part of Kraft Foods to other features of the standard.

FUNCTIONS OF THE DEPARTMENT OF AGRICULTURE IN RELATION TO DEFINITIONS, STANDARDS, AND GRADES OF CHEESE

by

E. Small, Dairy Division, Agricultural Marketing Service

Although it would be impossible in a relatively short time to treat all the facets of the subject matter assigned, I'll try to cover some of the more significant ones.

The Food and Drug Administration concerns itself with definitions and standards of identity and wholesomeness of the product, whereas grade standards relate to refinements of marketable quality.

In addition to developing grade standards, we cooperate with the General Services Administration in the preparation and revision of Federal Specifications for all dairy products.

Fluid milk and milk products which are covered by the Grade A program are under the jurisdiction of the U. S. Public Health Service and similar agencies.

Under Public Law 733 known as the Agricultural Marketing Act of 1946, and previous similar laws, the Secretary of Agriculture has been authorized and directed to promulgate grade standards for agricultural products.

Specifically the Dairy Division, AMS, is charged with the responsibility of developing grade standards for manufactured dairy products, including cheese. Since the main interest and grading activity for cheese relates to cheddar cheese we will confine our remarks to this product.

History of Grade Standards for Cheddar Cheese

The original grade standards for cheddar cheese were developed after thorough and careful investigation in the early twenties. These grade standards were promulgated in January, 1923, under the food products inspection law. They were designed on the basis of the score-card system. During World War II we abandoned the score-card method of prorating the score to the various quality factors and employed a more direct method of classifying each quality factor. The revised grade standards were promulgated in May, 1943 and were revised slightly in December, 1950. A comprehensive revision of the grade standards was issued in May, 1956.

Fundamentals of Grade Standards

Grade standards to be of maximum value should encompass the full range of marketable quality and should be based on factors that can be uniformly applied. With respect to manufactured dairy products they should, insofar as possible, reflect the quality of the raw milk and/or hygiene of manufacture.

Grade standards, to be realistic and effective, do not change according to market conditions or from season to season--the same considerations apply to the interpretation and application of the standards through grading activity.

Present Grade Standards

The present grade standards which were adopted in May, 1956, are more complete, specific and informative than earlier standards. Proper application and use of these grade standards should aid the industry in marketing and merchandising cheddar cheese.

Grading Cheddar Cheese

The Dairy Inspection and Grading Branch is charged with the responsibility of determining the grade in accordance with the U. S. Standards for Cheddar Cheese.

A summary (Table I) of the grading data was tabulated from a representative group of grading certificates covering cheddar cheese offered for sale to the Commodity Credit Corporation during the period July 1956 through June 1957. During this period, the government purchased 206,015,303 pounds of U. S. Grade A paraffined cheese. The summary represents a total of 55,410,455 pounds (approximately 1665 carlots) offered for possible sale to the Commodity Credit Corporation of which 91.0 percent met the purchase requirements of U. S. Grade A. The balance consisted of: 8.0 percent of U. S. Grade B, 1.0 percent U. S. Grade C and less than one-hundredth of one percent was classified as Below Grade. The sampling represents one-fourth (24.5%) of the paraffined cheese offered.

Cheddar cheese from sixteen states was included in the paraffined cheese summary with the majority of the cheese offered from nine midwestern and southern states.

A separate tabulation (Table II) of all the rindless cheddar cheese offered to CCC was prepared for the same period. This summary was prepared on the basis of reporting multiple defects for any given vat of cheese. In other words, when more than one defect was shown on the certificate, for any vat, each was recorded and the same poundage tabulated for each defect.

Six states were represented in this summary of the rindless cheddar cheese comprising a total of 14,972,750 pounds offered, of which 12,447,604 pounds or 83.1 percent graded U. S. Grade A. Of this amount 12,141,138 pounds were purchased. Of the total graded 15.9 percent was U. S. Grade B, 0.9 percent U. S. Grade C and less than one-tenth of one percent was classified as Below Grade.

The results of these tabulations are shown below in Tables I and II, respectively.

Due to the duplication of poundage for the multiple defects reported it was not possible to compute the exact percentages for each quality factor in arriving at the grade-out breakdown. Therefore the percentages reported below for each quality factor totals more than 100 percent.

TABLE I
TABULATION OF REASONS FOR "GRADE-OUTS" ON PARAFFINED
CHEDDAR CHEESE, JULY 1956 - JUNE 1957

Flavor (18.00%)		Body and Texture (53.06%)		Color (2.34%)		Finish and Appearance (26.60%)	
Utensil	22.7%	Gassy	47.8%	Mottled	65.7%	Blistered paraffin	38.3%
Acid	20.4	Open	28.9	Seamy	18.1	Wet rind	29.6
Yeasty	19.1	Weak	6.4	Acid-cut	7.4	Mold under paraffin	12.8
Old milk	12.3	Sweet holes	3.7	Salt spots	7.0	Checked rind	4.5
Weedy	6.2	Crumbly	3.7	All others	1.8	High edges	2.8
Fruity	5.6	Slitty	2.6	Unnatural		Cracked rind	2.3
Onion	5.3	Pinny	2.4	Dull		Sour rind	1.9
Whey taint	4.1	All others	4.5			Scaly paraffin	1.9
All others	4.3	Short				Weak rind	1.5
Bitter		Corky				Huffed	1.4
Metallic		Mealy				All others	3.0
Feed		Pasty				Soiled surface	
Sour		Coarse				Rough surface	
Flat		Curdy				Lopsided	
Lipase						Checked paraffin	
						Broken bandage	
						Rind rot	
						Soft spots	
						Irregular bandage	

TABLE II
TABULATION OF REASONS FOR "GRADE-OUTS" ON RINDLESS
CHEDDAR CHEESE, JULY 1956 - JUNE 1957

Flavor (37.5%)		Body and Texture (81.2%)		Color (2.8%)		Finish and Appearance (6.8%)	
Utensil	21.3%	Gassy	53.3%	Mottled	53.3%	Rough surface	27.4%
Acid	19.2	Open	25.3	Seamy	30.3	Moisture under wrapper	26.4
Yeasty	12.9	Short	6.6	Acid-cut	8.0	Loose wrapper	20.3
Old milk	11.4	Slitty	3.4	Faded	5.2	Mold under wrapper	17.6
Weedy	10.9	Weak	2.7	All others	3.2	Huffed	2.6
Fruity	8.3	Coarse	2.7	Extraneous matter		Broken wrapper	2.4
Bitter	8.1	Corky	2.0	Salt spots		Checked surface	2.2
All others	7.9	Crumbly	1.5			Soiled surface	.6
Whey taint		Pinny	1.1			Wrinkled wrapper	.5
Onion		Mealy	.7				
Sour		All others	.7				
Lipase		Sweet holes					
Rancid		Pasty					
		Curdy					

Quality Improvement

It is quite generally known that a substantial amount of cheese offered for sale to the government is pregraded or at least screened prior to being officially graded by Federal or Federal-State graders. Also, up to three-fourths of the cheddar cheese production is not exposed to such grading and a significant portion of this cheese would probably not qualify for U. S. Grade A. Moreover, when grading cheese 10 to 21 days old, as in the case of the Price Support program, a certain amount of grading failures are inescapable. Consequently we cannot begin to assume that 91 percent of all of the paraffined cheddar cheese produced in this country would qualify for U. S. Grade A. Actually we have a long way to go toward improving the overall quality of cheddar cheese in this country.

One of the prime objectives of grade standards is to facilitate trading and to stimulate quality improvement, uniformity and stability of product.

Too much emphasis cannot be placed upon the importance of the quality of the raw milk. Only a few states have adequate requirements for the production of quality milk for manufacturing purposes, others have few or no applicable regulations. Improvement in the quality of milk for manufacturing purposes will tend to narrow the range of quality within grades and hence help bring about a general uplifting of the quality standards for cheddar cheese.

There are no short cuts or detours to quality improvement. The achievement of a sound quality improvement program will require a lot of hard work and team effort on the part of everyone concerned.

NEW DEVELOPMENTS IN THE PROPAGATION OF STARTERS: NEW EQUIPMENT AND PLANT PRACTICES

by

M. W. Hales, Chr. Hansen's Laboratory
Milwaukee, Wisconsin

Recently, many cheesemakers have been using two or more multiple-type cultures to prepare their bulk starter. This practice yields more uniform acid development and other desired characteristics of bulk starter. Also, it appears to minimize some of the inhibitory effects of milk. To obtain maximum success with this practice, the cultures must be known to be able to grow together. The individual cultures for the mixture should be propagated independently as mother cultures and as intermediates, and mixed only in the bulk starter tank to prevent dominance of a few strains. All cultures must be protected against contamination from the air, particularly against bacteriophage. Multiple-strain cultures should not be carried too long in the cheese factory as mother cultures. The frequent or daily use of fresh "seed cultures" in the freeze dry form to prepare mother or intermediate cultures has resulted in definite improvement.

Currently tests are being made on a procedure for mixing selected single-strain lactic cultures, each combined with a compatible associate or citric acid fermenting organism. With this method, pairs of single strains would be used each day, with enough pairs available so that different cultures can be used each day for a period of at least a week without duplication of strains. The citrate fermenting bacteria seem to "bolster" the hardiness of cheese cultures and to aid in developing the desired Cheddar cheese flavor. Also, they stimulate acid production by lactic cultures.

For sustained good performance of lactic cultures, it is difficult to surpass high quality skim or whole milk that has been heated with care and moderation. However, due to unpredictable variations which may occur in the growth supporting properties of natural milk, pretested nonfat dry milk solids are being used in many cheese factories for propagating starters. Such milk solids should be tested and proved capable of supporting good growth and activity of a number of different lactic cultures during repeated propagations for at least a week, preferably a longer period. Testing with one culture for one or two propagations has been found to be insufficient. A special phage-resistant medium for lactic cultures has attracted attention recently. It is essentially a low-calcium, milk solids medium.

The third general condition for effective control and performance of cheese cultures and starters involves adequate protection against bacteriophage, the "number one enemy." The procedure being employed in certain foreign countries and increasingly in this country includes:

1. Provision for separate facilities for culture and starter operations, well isolated from the manufacturing rooms and with independent, filtered air.

2. Rotation of different cultures that have unrelated bacteriophage sensitivity patterns.

3. Use of protective starter making equipment, including:

    A. Water-sealed and filter-equipped starter cans with protected inoculating spouts. Inoculations are made through a jet of steam.

    B. Air tight equipment which avoids any exchange of air during heating and cooling. Flexible polyethylene bottles, sealed with serum-type rubber stoppers, are an integral part of the system. Inoculations are made through the stoppers with a specially designed, double-needled device which is the equivalent of two hypodermic needles end to end.

Substantial evidence has been presented for a need of such control measures and the benefits resulting therefrom. Following their use, the improvements reported in cheesemaking records have been outstanding.

Bacteriophage control measures may take a different form, if a phage-resistant medium proves to be successful and is accepted for use in this country. However, the proper use of presently proved and acceptable procedures and equipment for propagating cheese cultures will aid greatly in maintaining uniformly active and bacteriophage-free starters.

NEW DEVELOPMENTS IN THE PROPAGATION OF STARTERS: CULTURE MEDIA AND PHAGE INHIBITION

by

F. J. Babel, Purdue University,
Lafayette, Indiana

For several years it has been known that bacteriophage active against Streptococcus lactis or Streptococcus cremoris does not develop in a calcium-deficient medium in the presence of host cells. Various investigators have attempted to develop a calcium-deficient medium that would support the growth of lactic cultures but in which bacteriophage would not multiply. This report concerns investigations on such a medium prepared from milk. The medium is designated PRM (phage resistant medium) and is an imported product.

In one series of experiments two bottles each of skimmilk and PRM were inoculated with 1% lactic culture (LC-14). One bottle of skimmilk and one of PRM were also inoculated with 1% of a bacteriophage preparation (B-14) having 10^5 particles per ml. The skimmilk containing culture only, and both bottles of PRM were coagulated after incubation at 70° F. for 16 hours. A bacteria-free filtrate prepared from the skimmilk inoculated with culture and bacteriophage had a bacteriophage titer of 10^9 per ml. A filtrate prepared from the PRM inoculated with culture and bacteriophage showed no bacteriophage activity in 1 ml. Another series of experiments were conducted using a bacteriophage preparation having 10^9 particles per ml. The use of 1% of this preparation gave an initial bacteriophage concentration of 10^7 particles per ml. With this concentration, the sensitive culture developed normally in PRM, but not in skimmilk. Additional trials with other cultures and their homologous bacteriophage have indicated that PRM does not support the development of bacteriophage and cell lysis does not occur in the medium even in the presence of a considerable amount of bacteriophage.

Initial studies on the growth of lactic cultures in PRM were conducted with the medium reconstituted at the 10% level. Transfers from PRM to PRM or skimmilk generally were slower in coagulation than a transfer of the same culture from skimmilk to skimmilk. The coagulum formed in PRM is very solid and it was thought that the slower rate of coagulation in PRM was due to a settling out of the inoculating material. Therefore, further trials were conducted with the medium reconstituted at the 7.5% level.

Growth studies on lactic cultures in PRM reconstituted at the 7.5% level were carried out with two different lots of powder; comparisons were made

at the same time with skimmilk. With most cultures, inoculations into skimmilk coagulated more rapidly than inoculations into PRM. However, a few cultures coagulated PRM just as rapidly, or somewhat more rapidly, than skimmilk. None of the cultures tested failed to grow in PRM.

Because of differences in the composition of PRM and skimmilk, growth of lactic cultures was determined in both media by plate counts. The culture media were inoculated with 1% of a 1:100 dilution of lactic culture and incubated for 5 hours at 30° C. Plate counts were made initially on tomato agar and again after the incubation period (5 hrs. at 30° C.). The plates were incubated at 30° C. for 48 hours. Trials with 10 different cultures indicated that skimmilk was superior to PRM in supporting growth of lactic cultures.

Although growth of some lactic cultures is delayed when PRM is used as the culture medium, the material has certain advantages. It does not permit development of bacteriophage and certain cultures contaminated with bacteriophage have been made phage-free with not more than three propagations in PRM. The necessity of a longer incubation time for some cultures carried in PRM is not a serious disadvantage.

RECENT RESEARCH ON STARTER FAILURES: THE PROBLEM

by
Ralph P. Tittsler
Eastern Utilization Research and Development Division

Intermittent starter failures in Cheddar, Cheddar-like and cottage cheese factories have attracted increased attention during the past decade, and they seemed to be increasing at an alarming rate a few years ago. In some instances, acid formation proceeds normally until it reaches about .15 - .20 per cent and then it stops; in others, it is abnormally slow and/or it never reaches the required percentage. Considerable economic loss has been encountered.

Some cheesemakers and research workers believe that starter failures are caused by bacteriophage; others believe that antibiotics used in treating mastitis, sanitizing agents, or cleaning materials are responsible. The ability of each of these to cause starter failure has been established. Also, the formation of anti-bacterial substances in milk by non-starter bacteria before the lactic starter is added has been suspected.

The Department of Agriculture was urgently requested to initiate research with the aim of determining definitely the cause of starter failures and developing specific means for preventing them. Such research seemed to be highly desirable because of the apparent economic importance of the problem over a broad geographical area.

In view of the different ideas and a lack of facts relative to causes of starter failures, it seemed imperative to first obtain conclusive data

concerning the relative importance of different causative agents in order to properly and specifically channel research toward prevenative procedures. Fact-finding research was initiated in October 1956 under a three-year contract with the W. K. Moseley Laboratory.

RECENT RESEARCH ON STARTER FAILURES: PROGRESS REPORT

by
Robert L. Winslow, W. K. Moseley Laboratory
Indianapolis, Indiana

Samples of cheese milk are being tested for antibiotics, quaternary ammonium compounds, and chlorine. Samples of whey and factory starters are being tested for bacteriophage. The samples are being obtained from factory cases of starter failures in many states during all seasons and they represent Cheddar, Cheddar-like, and cottage cheeses. Also, similar samples from failure-free factories are being tested likewise. The air in factories having starter failures and in failure-free factories is being tested for bacteriophage. A possible relation of starter failures to procedures and equipment used for propagating starters and for making cheese is to be investigated.

During the past year, samples representing 57 factory cases of starter failures (including 26 Cheddar cheese cases) in 11 states were tested. They included 40 milk samples, 54 starter samples, 61 whey samples, and 20 air-exposed samples. The analytical results were as follows: of the 40 milk samples, 12 (30%) contained antibiotics, none contained quaternary ammonium compounds, and 18 (45%) gave positive tests for chlorine; and 46 (85.2%) of the 54 starter samples, 56 (91.8%) of the 61 whey samples, and 6 (30%) of the 20 air samples contained bacteriophage. The results with samples from Cheddar cheese factories were practically the same as those with samples from Cheddar-like and cottage cheese factories.

Samples have been tested likewise from 15 cheese factories (12 Cheddar) in 7 states when they were not having starter failures. Five factories had not had starter failures for at least six months and ten had experienced failures during the six months prior to sampling. There were 14 milk, 15 starter, 15 whey and 12 air samples. The analytical results were as follows: of the 14 milk samples, 2 (14.3%) contained antibiotics and none contained either quaternary ammonium compounds or chlorine; and 13 (86.7%) of the 15 starter samples, 11(73.3%) of the 15 whey samples, and 1 (8.3%) of the 12 air samples contained bacteriophage. The results were similar regardless of whether the samples were from Cheddar, Cheddar-like, or cottage cheese factories, or whether the period between the last starter failure and the time of sampling was more or less than six months.

The absence of quaternary ammonium compounds in all 54 milk samples analyzed indicates that these compounds were not significant as causes of any of the 40 failures which they represented. Although chlorine was indicated in 45% of the 40 milk samples received from plants experiencing failures but not

in any of the 14 milk samples from failure-free plants, the significance of this observation is highly questionable. Copper, in amounts which would be present in milk processed through equipment or fittings fabricated of copper-bearing alloys, e. g. white metal, produces a false-positive test for chlorine so that many or all of the positive tests for chlorine actually may have been due in part or entirely to copper.

Of the factors which have been considered so far in this study, antibiotics and bacteriophage appear to be most significant. Antibiotics were found in 30% of the 40 milk samples representing starter failure cases and bacteriophage was found in starter or whey samples from 93% of the 57 starter failure cases. In every starter failure case in which antibiotics were found, bacteriophage was also found. On the other hand antibiotics and bacteriophage were also found both individually and in combination in samples from the plants not experiencing failures. Antibiotics were found in 15% of the 14 milk samples from failure-free plants and bacteriophage was found in samples from 80% of the failure-free plants.

It is apparent from the results obtained with the failure-free control plants that some plants are able, at least part of the time, to obtain normal acid development in their cheese even though there are antibiotics in the milk and/or bacteriophage in the cheese vat.

TREATMENT OF MILK FOR CHEESE WITH HYDROGEN PEROXIDE

by

Z. D. Roundy, Armour & Company

For many years dairy technologists have experimented with hydrogen peroxide and catalase for treating milk to be used in the manufacture of cheese, but the results reported have been generally disappointing.

Our work has shown that Swiss and Cheddar cheeses of excellent quality and uniformity can be produced from milk properly treated with small amounts of hydrogen peroxide and catalase.

Hydrogen peroxide has a selective action on bacteria. Data show that the aerobic, spore-forming organisms are most resistant to destruction by hydrogen peroxide and the coliform organisms the least resistant. The susceptibility of the lactic-acid organisms is intermediate. The object of these experiments was to use concentrations of peroxide that would destroy most of the objectionable organisms (principally coliform organisms) in milk, yet have the least effect on the milk itself and the lactic acid organisms in it.

Two methods of treating milk with peroxide were investigated: the vat method and the so-called flash method. In the former method, the milk was treated at temperatures either between 120° and 130° F. or between 86° and 94° F. (setting temperatures). After the designated holding time, the peroxide was destroyed by catalase. Although it is possible to produce cheese of satisfactory quality by adding peroxide to the milk in the vat, there

are some disadvantages connected with this procedure.

Vat-treatment of milk at 120 - 130° F. was considered impractical for large-scale operations because adequate cooling facilities are not always available. When the milk was treated at 86 - 94° F., the catalase naturally present in the milk decomposed some of the peroxide before it had had time to act on the organisms. Furthermore, hydrogen peroxide is less active at these temperatures than at higher temperatures. The activity of hydrogen peroxide solutions increases approximately two times for each 10° rise in temperature, other things being equal.

The flash method was tried next. The milk was treated at 130° F. with 0.06% hydrogen peroxide (calculated as 100%). Since this treatment destroyed most of the desirable lactic-acid organisms, the concentration of peroxide was reduced in subsequent experiments. Brief description of the method, which was adopted for routine experimental purposes, follows:

Clarified milk is treated in the surge tank with 0.02% hydrogen peroxide. The peroxide solution is added to the milk by means of a flowmeter. From the surge tank, the treated milk passes through a high-temperature, short-time (HTST) plate-type pasteurizer, where it is heated to approximately 125° F. for about 25 seconds. It is then cooled to the setting temperature (86° F. for Cheddar cheese or 94° F. for Swiss cheese) before it is delivered to the vat. During filling, or when the vat is full, catalase is added to decompose the peroxide.

It is essential that all the peroxide in the milk be decomposed before starting the cheese-making operations, otherwise the starter organisms fail to grow. Excess catalase does no harm.

Three to four times the required theoretical amount of catalase is used to hasten the decomposition of the peroxide. The potassium iodide-starch test, or the para-phenylenediamine dihydrochloride test, is used to test for the presence of peroxide. When the milk is free of peroxide, starter is added and the cheese is made in the usual manner.

Treatment of milk at approximately 125° F. for about 25 seconds with 0.02% peroxide destroys nearly all of the coliform organisms and leaves intact more of the natural enzymes and beneficial organisms than accepted pasteurization procedures. Consequently, cheese made from milk properly treated with a small amount of hydrogen peroxide and catalase ripens faster and usually has a finer flavor and body than pasteurized-milk cheese.

PROBLEMS IN THE ITALIAN SOFT CHEESE INDUSTRY

by
Frank V. Kosikowski, Department of Dairy Industry, Cornell University, Ithaca, New York

Originating centuries ago in southern Italy are two well-known soft cheeses, Mozzarelle and Ricotta. These fit together well in the cheese manufacturing

scheme because one cheese results from the side product of the other.

Traditionally, Ricotta, or recooked cheese, has been made from the whey of Mozzarelle and other "pasta-filata" types. To this whey a small amount of skim milk is often added to improve the final texture. A joint application of acid and high heat results in a protein precipitate which is removed as cheese.

New York City is the mecca for Ricotta, especially at Easter time, but other cities are becoming important consumer centers. Ricotta is used directly in salads, in ravioli, in cheese cake and as cream whipped fillings for desserts. It can be consumed also just as one eats cottage cheese. Good quality Ricotta has a soft, fragile texture, and a sweet, walnutty flavor.

In the East, cheese from whole milk and from part skim, usually 2 per cent fat, have become much more popular than the product from whey and the following classification is in general use:

Ricotta - that cheese from whole milk
Part-skim Ricotta
Ricotone - that cheese from whey
Dry Ricotta

In areas other than the East, relatively little cheese is made from whole or part-skim milk and the term, Ricotta, usually denotes that cheese obtained from whey.

Difficulties are common in the coagulation of proteins of whole milk and skim-milk Ricotta. Required is an almost simultaneous precipitation of casein, lactoalbumin and lactoglobulin. At times conditions are not entirely suitable and a second precipitation must follow to recover fully the cheese curd. The color of the whey, clear green or milky, is a good indicator of the efficiency of the initial precipitation.

Few appreciate the world-wide importance of the pasta-filata principle of cheesemaking. In this system the texture and grain of the cheese are achieved through a skillful stretching of curd in hot water. Provolone, Caccicovolla and other cheese owe their characteristics to this principle. Yet, it is a soft non-aged cheese, the Mozzarelle, which is the foundation for all pasta-filata type cheese. Knowledge of the manufacture of Mozzarelle provides a good start on these other cheeses.

Approximately 24 million pounds of soft Italian cheese are produced annually in New York State, much of it Mozzarelle. Its increased popularity parallels that of the well-known Italian specialty, Pizza Pie. Mozzarelle cheese is consumed in its natural state, in the preparation of lasagne, and in veal cutlet a la Parmagiana.

Presently, some confusion exists as to the nature of true Mozzarelle cheese. Made in the East the cheese, generally, is white with a soft texture and a high moisture, milky consistency and possessing a bland flavor. Made in the Midwest the cheese, generally, is yellowish, drier, and frequently displays a slight Provolone flavor. It may be called Mozzarelle-Provolone or

Pizza cheese. Eastern whole-milk cheese contains about 50 per cent moisture and 19 per cent fat, while Midwestern cheese averages 46 per cent moisture and 23 per cent fat.

The Italian cheese industry is faced with many problems, but two of immediate urgency are concerned with poor sanitary quality and a lack of state and national standards of identity.

Both Ricotta and Mozzarelle cheese often are heavily contaminated with mold, yeast, and coliforms. This is particularly significant with Ricotta because supposedly it leaves the hot kettle in an almost sterilized condition. Yet when Ricotta cheese is packaged in plastic consumer cups dramatic evidence frequently is displayed of poor sanitary quality through exploding caps and obnoxious flavors.

The decision of the Federal Food and Drug Administration not to promulgate standards of identity for Ricotta and Mozzarelle cheese at this time has been received with some misgivings. Standards are urgently needed for the elimination of the chaos apparent in certain segments of this industry. Manufacturers would do well to sit down together and work out the general basis for satisfactory standards of identity on a nation-wide basis.

THE MANUFACTURE OF HIGH-QUALITY COTTAGE CHEESE

by

Milton E. Powell, Knudsen Creamery Co. of California

Sales and merchandising policies, as well as rigid manufacturing procedures, must be attuned to place high-quality cottage cheese in the home. It is more difficult to produce this product than it is to process a high-quality market milk, and people must be trained in this concept.

Naturally, the basic skim milk used for making the cheese must be of top quality; this is no place for high-acid incoming milk. It must be pasteurized, and temperatures slightly above the legal limits may be advantageous to use. When the solids of the milk are below 9.0 per cent it is difficult to make the large-curd cheese. These curds have to shrink so much during the cooking process they frequently shatter. Fortification of low-solids milk with low-heat skim-milk powder or condensed skim to a level near 10 per cent solids will be advantageous. The actual yield of cheese is increased as well as the capacity of the cheese vats.

Starters used for cottage-cheese production must be chosen carefully. The flavor produced by the starter is not too significant, unless it is an objectionable off-flavor. Any potential diacetyl flavor which is produced during the setting is generally washed out of the curd later in the process. Some cultures contain too many flavor organisms to be used for cottage-cheese purposes, as these starters produce considerable quantities of gas. Starters will vary in the strength of the clabber that is produced. Some strains of cultures will not produce a satisfactory rennet curd, but can be used for the straight acid type if it is cut into small-sized cubes.

The plant-production schedule will determine whether the long overnight, an 8-hour intermediate, or a 5 - 6-hour short set is to be used in souring the milk. These are simply variations in setting temperature and per cent of inoculum. The shorter setting times are easier to control, and also allow the equipment to be used more frequently.

The time for cutting the curd may be determined by pH or by its acidity. If the acidity test is used the cheesemaker must know the SNF of the fluid skim milk, for the higher the solids the higher the cutting acidity that is necessary. If the curd is cut according to pH there are times when the point chosen for cutting is reached before the curd seems ready. The pH meter may be too sensitive an instrument for routine use in the plant.

After the curd has been cut, care and patience in cooking and stirring are needed. Too rapid heating produces a tough shell on the surfaces of the cubes; this prevents the whey from escaping from the interior. Too violent stirring will break the large curds, but mechanical agitators may be used for stirring the small curds during the last half of the cooking process.

In determining the end of the cooking process, a handful of the small curd may be washed in cold water and its springiness observed when squeezed lightly in the hand. The large curd is also tested this way but in addition several curds are broken open and observed for the presence of whey pockets.

When the curd is properly cooked the whey should be rapidly drained to the top of curd and tap water added to equal the volume of whey removed. The cheese must be stirred to prevent it from matting. The temperature of the first wash water should equalize itself in the vat to about 90° F. This water is removed and a second tap water wash used. A final washing in water chilled below 40° F. will cool the curd thoroughly. After complete drainage of this water the cheese may be removed for creaming or creamed in the vat.

The water used throughout the cheesemaking operations can present a dual problem. The bacteriological quality must be controlled through chlorination. Certain waterborne organisms cause a slimy gelatinous growth on the surface of the finished cheese. Finally, the chemical composition must be recognized. In alkaline waters with a pH above 8.0 the curd is actually repeptized and a soft slimy product results. It is necessary to acidify such water to reduce the pH to 7.0 or below.

LABOR-SAVING METHODS FOR MAKING CHEDDAR CHEESE

by
Homer E. Walter
Eastern Utilization Research and Development Division

Labor-saving procedures and equipment for making Cheddar cheese are urgently needed to compensate for increased labor costs. Also, means for improving the flavor and uniformity of cheese are needed to increase consumption.

Conventional methods for making Cheddar cheese require much hand labor, particularly during the cheddaring or matting process. Several commercial

cheese companies, equipment makers, and State Agricultural Experiment Stations attempted to develop a stirred-curd method that would require appreciably less hand labor and consequently reduce manufacturing costs. Some workers achieved a fair degree of success, but in general the resultant product had a more open texture than that characteristic of Cheddar cheese. Satisfactory results were not obtained when these proposed methods were tested in our laboratory. The texture of the cheese was too open.

Earlier, promising results were obtained by the Department when salted curd was hooped in salted whey. This finding resulted in the development of a short-time method which was reported in 1953. There were, however, recognized objections to certain parts of that method. It required special types of cheesemaking equipment. Also, approximately one-half of the whey was unusable because it contained 4 per cent added salt.

Australian investigators carried out extensive studies with our method and concluded that it was not commercially acceptable, particularly because of the hooping in salted whey. However, using some of the basic principles of our method, they developed a method that was accepted by several of their commercial factories and cheese was made for export.

Continued research in our laboratory resulted in several important changes in the original procedure. The amount of salted whey for hooping the curd was reduced significantly, and most of the special equipment was eliminated. The simplified short-time method was reported in 1955. Briefly the method is as follows:

> The starter employed is a mixture of a conventional lactic starter and the heat and salt tolerant Streptococcus durans which are propagated separately. The starter and rennet are added to pasteurized milk at 88° F. The curd is cut and cooked to 100° F. in a conventional Cheddar-cheese vat. The whey is drained off and the curd is salted. The salted curd is hooped at about 110° F. in a small volume of either salted whey or salted water, drained under pressure for a few minutes, and pressed overnight in a conventional cheese press. The method requires only three hours until the curd is pressed, instead of the conventional $5\frac{1}{2}$ to $6\frac{1}{2}$ hours.

The quality of the cheese made by this method is excellent. It has a clean, mild flavor and an extremely close texture. However, some persons have objected to this close texture and the lack of mechanical openings. Also, some have objected to a need for additional hooping equipment.

In view of these objections, it seemed desirable to investigate possible changes that might be made in the simplified method. It was decided to approach the problem on the basis that: (1) a saving of labor is more important than a saving of time; (2) some mechanical openings in Cheddar cheese are not undesirable; and (3) a labor-saving method should deviate as little as possible from conventional methods.

A simple change in the conventional method seems to offer a practical means for saving much hand labor. The new method has been tested repeatedly on a pilot-plant scale. It has not been tested on a commercial scale, and there-

fore, only recent experimental results can be reported.

With the new method, the conventional 7-hour method of making Cheddar cheese from pasteurized milk is followed until dipping time. Then, the misture of curd and whey is pumped into a cheese clothed lined curd retention and matting device. The curd falls to the bottom, forming a layer under the whey. When the total contents of the vat have been pumped into the container, the cheese cloth is folded over the curd, and a pressure of 30 pounds per square foot is applied. The whey drains from the curd and the curd mats for 2 hours. Then the cheese cloth is removed and the curd is cut into 3/4 inch slabs and milled. Conventional procedures are followed in milling, salting, hooping, dressing, and pressing the curd. All of the hand labor required during the conventional two-hour matting period is eliminated. Further, the cheese vat is available for reuse when pumping is completed.

Cheese made with this method has had a typical Cheddar-cheese flavor, a few mechanical openings, and a firm, waxy body.

Various bacteria have been used as starters. Some of them have sufficient heat resistance to withstand a cooking temperature of 115° F. Matting periods have been varied from 1 to 20 hours. The moisture content of the cheese has ranged from 31 to 38 per cent, usually 36 to 38 per cent, depending on temperature and period of matting.

UTILIZATION OF WHEY IN FOOD PRODUCTS

by

C. A. Alesch, Western Condensing Company, Appleton, Wisconsin

Edible dairy whey solids are a new type of dairy ingredient for the food industry, and can be utilized effectively as a basic dairy ingredient for their functional and nutritive value.

The use of liquid whey was, and is, impractical. It must be concentrated and dried quickly under rigid sanitary control if it is to be used in food products. Substantial quantities of whey are recovered for use in animal feeds also, but in many cheese plants whey constitutes a serious disposal problem. (It was estimated during the discussion that about one-half of the cheddar-cheese whey produced is processed into salable products).

The centralized cheese-producing operations and the modern processing and drying plants have made whey accessible, thus making the drying of an economical high quality dairy whey product a reality.

A quality whey product conforms with or exceeds the Standards for Dry Whey (USDA 19 F. R. 3349). Careful control of the entire processing phase from the whole milk to the condensed and dried product insures the food manufacturer a whey product that compares with premium grades of whole milk and nonfat dry milk.

The unique composition of whey (72% lactose, 13% lactalbumin protein, 11% mineral, 4% moisture) provides specific functional properties to various food

products that cannot be obtained by using other type dairy solids. Thus, whey solids and byproducts of whey (lactose, lactalbumin and combinations of these constituents) are being utilized effectively in such foods as bakery products, confections, comminuted meats, ice-cream products, soups and beverages.

Whey solids and nonfat dry milk exhibit a supplementary effect when incorporated into specialty bread formulas. Whey solids are especially valuable for their contribution to improved crumb, color, and texture in baked goods.

CHEMISTRY OF CHEESE FLAVORS

by

W. J. Harper, Department of Dairy Technology, Ohio Agricultural Experiment Station and Ohio State University

The characteristic flavor of a cheese is developed as a result of a series of complex enzymatic reactions which produce several hundred chemical compounds of many different types. Compounds such as lactic acid, amino acids, salt, nonvolatile amines, and fatty acids contribute to the base of the flavor or the taste component, whereas compounds such as fatty acids, aldehydes, ketones, alcohols, esters, volatile sulfides and mercaptons contribute to the aroma. Just as in a perfume, both the base and aroma constituents must be present in the proper balance to give the full desired flavor.

The exact role of each compound present in cheese in relation to flavor is not yet known, but the flavor must be a blend of many components. Any compound present at threshold or even at subthreshold levels of taste or smell could contribute to the flavor. From flavor studies of other foods it is impossible to predict in advance the effect of one component on flavor when it is mixed with other constituents. Therefore many compounds probably contribute to a greater or lesser extent to the characteristic flavor of cheese.

In determining the relationship between a chemical compound and flavor, several criteria have been used: (1) association between the concentration of the compound and the degree of characteristic flavor and (2) determining the effect of the compound on the flavor profile by adding it to cheese or a bland base. However, these criteria are not infallible and have several inherent errors. The association of concentration of a compound to flavor can mean that the compound (a) is formed simultaneously with a flavor compound, (b) is a precursor of a flavor constituent or (c) is a flavor component. The failure of a compound to reproduce or enhance flavor may not exclude the compound from being a flavor constituent since the compound may: (a) not be in the chemical form present in cheese, (b) be in imbalance with other unknown but needed constituents, (c) require another compound to effect an influence on flavor.

Experimental evidence has indicated an association of some chemical compounds with flavor, although their exact role in flavor remains obscure. Amino acid amines, fatty acids, methyl ketones, H_2S, methyl mercaptons have all been sho to be associated with flavor of some cheeses. The principle of dependence on balance of constituents has been shown in the case of Provolone Cheese, where

both glutamic acid and butyric acid must be present in certain threshold levels before characteristic flavor is observed. A similar relationship between proline and propionic acid in Swiss Cheese has been reported also. Undoubtedly other compounds are important in the flavor of these cheeses. As research tools improve, a more complete picture of the nature of cheese flavor will result.

The chemical compounds in cheese are in a dynamic state of continual change. Changing microbial populations utilize as substrates the end products of previous fermentations. Changes in ripening environment may cause changes to occur in the rate or even direction of enzymatic equilibrium. Extensive interrelations exist between enzymatic processes involving the initial products of fat, protein and carbohydrate metabolism.

The ever-changing nature of the system and the large number of possible flavor components create a tremendous challenge to research. The rapid development and improvement of techniques is making possible the meeting of this challenge.

LIST OF ATTENDANCE

Name	Organization	Address
Alesch, C. A.	Western Condensing Company	Appleton, Wisc.
Alford, J. A.	Eastern Util. Res. & Devel. Div.	Beltsville, Md.
Anderson, W. B.	National Dairy Products Company	Washington, D. C.
Angevine, N. C.	Meyer-Blanke Co.	St. Louis, Mo.
Arbuckle, W. S.	University of Maryland	College Park, Md.
Babel, F. J.	Purdue University	Lafayette, Ind.
Baldwin, R.	Baldwin Dairies, Inc.	Philadelphia, Pa.
Barbary, D.	Sealtest, Western Maryland	Baltimore, Md.
Barnhart, J. L.	University of Idaho	Moscow, Idaho
Bartle, E. R.	Agricultural Marketing Service, USDA	Minneapolis, Minn
Bassette, R.	University of Maryland	College Park, Md.
Bates, H.	Breakstone Foods	New York, N. Y.
Beacham, L. M., Jr.	Food and Drug Administration	Washington, D. C.
Bell, R. W.	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Boncyk, C.	Marathon Corporation	Menasha, Wisc.
Bormuth, W. D.	Agricultural Marketing Service, USDA	Washington, D. C.
Boyd, E. N.	Agricultural Research Service, USDA	Washington, D. C.
Boyd, J. C.	Montana State College	Bozeman, Montana
Brice, J. D.	University of Maryland	College Park, Md.
Brightman, M. H.	7012 Wake Forest Drive	College Park, Md.
Bronsdon, W. P.	Sealtest, Western Maryland	Baltimore, Md.
Brown, E. E.	Jerome Cooperative Creamery	Jerome, Idaho
Bryant, R. S.	Victor Chemical Works	Chicago, Ill.
Burgwald, L. H.	Foreign Agricultural Service, USDA	Washington, D. C.
Burke, J. G.	The Borden Co.	Watertown, N. Y.
Burkey, L. A.	Agricultural Research Service, USDA	Beltsville, Md.
Buyens, H. J.	Swift & Co.	Chicago, Ill.
Cassell, L. B. (Mrs.)	Eastern Util. Res. & Devel. Div.	Washington, D. C
Corbin, E. A., Jr.	Eastern Util. Res. & Devel. Div.	Washington, D. C
Cordes, W. A.	National Dairy Products Corp.	New York, N. Y.
Cosgrove, C. J.	Rhode Island Agric. Expt. Sta.	Kingston, R. I.
Crowley, E. F.	Crowley's Milk Co., Inc.	Binghamton, N. Y
Cundall, H. H., Jr.	National Dairy Products Corp.	Albany, N. Y.
Currier, L.	H. P. Hood & Sons	Boston, Mass.
Dahlberg, A. C.	Cornell University	Ithaca, N. Y.
Davis, O. H.	Wilson & Co.	Chicago, Ill.
Day, E. A.	University of Maryland	College Park, Md
Deane, D. D.	Iowa State College	Ames, Iowa
De Cicco, M. J., Jr.	Sealtest Supplee	Philadelphia, Pa
Detjen, E. W.	Stoelting Brothers Co.	Kiel, Wisc.
Detwiler, S. B., Jr.	Eastern Util. Res. & Devel. Div.	Washington, D. C
Dizikes, J. L.	Agricultural Marketing Service, USDA	Chicago, Ill.

Name	Organization	Address
Eakle, D. E.	Chr. Hansen's Laboratory	Milwaukee, Wisc.
Edmondson, L. F.	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Elliker, P. R.	Oregon State College	Corvallis, Ore.
Ernstrom, C. A.	University of Wisconsin	Madison, Wisc.
Evans, D. A.	Mass. Agric. Expt. Sta.	Amherst, Mass.
Farrar, R. R.	Minnesota Cheese Industries Assoc.	St. Paul, Minn
Feinstein, L.	Agricultural Marketing Service, USDA	Beltsville, Md.
Fenton, F. E.	Agricultural Marketing Service, USDA	Washington, D. C.
Ferris, R.	Nelson Ricks Creamery Co.	Salt Lake City, Utah
Figy, C.	Office of Secretary, USDA	Washington, D. C.
Filkins, E.	Kusel Dairy Equipment Co.	Watertown, Wisc.
Foster, H. G.	Swift & Co.	Chicago, Ill.
Fram, Mr.	National Dairy Res. Labs., Inc.	Oakdale,L.I.,N. Y.
Frederiksen, F. M.	Treasure Cave	Faribault, Minn.
Freeman, A. F.	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Freeman, T. R.	Kentucky Agric. Expt. Sta.	Lexington, Ky.
Gaumnitz, E. W.	National Cheese Institute	Chicago, Ill.
George, J. S.	Tillamook County Creamery Assoc.	Tillamook, Ore.
Gold, H.	Breakstone Foods	New York, N. Y.
Gold, T. S.	Office of Secretary, USDA	Washington, D. C.
Gottlieb, I.	Harry Gottlieb, Inc.	Baltimore, Md.
Graham, D. M.	Clemson College	Clemson, S. C.
Graham, M. A. (Mrs.)	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Grant, F. M.	Agricultural Research Service, USDA	Beltsville, Md.
Greenbank, G. R.	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Greer, D.	Armour and Co.	Chicago, Ill.
Guest, L. (Miss)	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Guyette, J. E.	Western Condensing Co.	Appleton, Wisc.
Hale, H. F. (Miss)	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Hales, M. W.	Chr. Hansen's Laboratory	Milwaukee, Wisc.
Haller, H. S.	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Hanrahan, F. P.	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Hargrove, R. E.	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Harman, E.	University of Maryland	College Park, Md.
Harper, W. J.	Ohio State University	Columbus, Ohio
Hartley, C.	Fairmont Foods Co.	Omaha, Neb.
Hertel, L. A.	Pure Milk Products Co.	Winsted, Minn.
Hinds, M. K.	Federal Extension Service, USDA	Washington, D. C.
Hird, E.	Abbotts Dairies, Inc.	Philadelphia, Pa.
Homberger, M.	National Dairy Res. Labs., Inc.	Oakdale,L.I., N.Y.
Honer, C. J.	Otto Milk Co.	Pittsburgh, Pa.
Hoover, S. R.	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Hufnagel, C. F.	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Hutter, E. K.	Hygrade Food Products Corp.	Quincy, Ill.

Name	Organization	Address
Irvine, O. R.	Kemptville Agricultural School	Kemptville, Canada
Irving, G. W., Jr.	Agricultural Research Service, USDA	Washington, D. C.
Jacobsen, D. H.	American Dairy Assoc.	Chicago, Ill.
Jadd, E.	Paul-Lewis Laboratories, Inc.	Milwaukee, Wisc.
Jaggard, G.	The Dairy Laboratories	Philadelphia, Pa.
Jaggard, J. J.	The Dairy Laboratories	Philadelphia, Pa.
Jasewicz, L. B. (Miss)	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Johns, C. K.	Department of Agriculture	Ottawa, Canada
Katz, I.	University of Maryland	College Park, Md.
Keeney, M.	University of Maryland	College Park, Md.
Kiehow, O. G.	Meyer Zausner, Inc.	New Holland, Pa.
Kinney, A. W.	Dixie Cup Co.	Easton, Pa.
Kinsey, W.	University of Maryland	College Park, Md.
Kissinger, J.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Kocher, R. B.	Marschall Dairy Laboratory, Inc.	Madison, Wisc.
Kosikowski, F. V.	Cornell University	Ithaca, N. Y.
Koval, F.	Ohio State University	Columbus, Ohio
Kristoffersen, T.	Ohio State University	Columbus, Ohio
Lahet, M. (Mrs.)	Meyer Zausner, Inc.	New Holland, Pa.
Lane, C. B.	Breakstone Bros., Inc.	Walton, N. Y.
Langhus, W.	Kraft Foods Co.	Glenview, Ill.
Lear, S. A.	New Jersey Agric. Expt. Sta.	New Brunswick, N.J.
Lease, C.	University of Maryland	College Park, Md.
Leber, H.	Dairymen's League Coop. Assoc., Inc.	Syracuse, N. Y.
Leeder, J. G.	Rutgers University	New Brunswick, N.
Levitan, M.	Challenge Cream & Butter Assoc.	Los Angeles, Calif
Leviton, A.	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Linden, H. K.	Agricultural Marketing Service, USDA	Madison, Wisc.
Linklater, P. M.	University of Wisconsin	Madison, Wisc.
Lloyd, J. H., Jr.	Chestnut Farms, National Dairies	Washington, D. C.
Lothrop, R. E.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Lundstedt, E.	H. P. Hood & Sons	Boston, Mass.
McClure, J. W.	Rieck Dairy Div.	Farmdale, Ohio
McDonough, F.	University of Maryland	College Park, Md.
Mars, B. S.	Agricultural Marketing Service, USDA	Washington, D. C.
Matchett, J. R.	Agricultural Research Service, USDA	Washington, D. C.
Matt, M. C.	Abbotts Dairies, Inc.	Philadelphia, Pa.
Mattick, J. F.	Maryland Agric. Expt. Sta.	College Park, Md.
Mattingly, W. A.	University of Maryland	College Park, Md.
Meharry, H. J.	Food & Agric. Org. of United Nations	Rome, Italy
Meise, F.	University of Maryland	College Park, Md.
Meister, H. E.	Agricultural Marketing Service, USDA	Washington, D. C.
Messenger, H. S.	Brock-Hall Flavor-Rich Dairy Prod.	Hamden, Conn.

Name	Organization	Address
Meyer, D.	H. P. Hood & Sons	Boston, Mass.
Mitchell, C. D.	Eastern Util. Res. & Devel. Div.	Beltsville, Md.
Mittaine, J.	Roquefort Assoc., Inc.	Paris, France
Mizak, S. C.	Brock-Hall Flavor-Rich Dairy Prod.	Hamden, Conn.
Moats, W. A.	Agricultural Marketing Service, USDA	Beltsville, Md.
Moore, H. C.	New Hampshire Agric. Expt. Sta.	Durham, N. H.
Morgan, M. E.	Storrs Agric. Expt. Sta.	Storrs, Conn.
Morris, H. A.	University of Minnesota	St. Paul, Minn.
Moseley, W. K.	Moseley Laboratory	Indianapolis, Ind.
Mucha, T. J.	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Musser, J.	Warners Dairy, Inc.	Red Lion, Pa.
Myers, S. A.	Meyer Zausner, Inc.	New Holland, Pa.
Nageotte, G. J.	Virginia Polytechnic Institute	Blacksburg, Va.
Overcast, W. W.	University of Tennessee	Knoxville, Tenn.
Pallansch, M. J.	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Patterson, W. I.	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Pedrick, R.	Dean Milk Co.	Rockford, Ill.
Pope, S. M.	Tolibia Cheese Mfg. Corp.	Fond Du Lac, Wisc.
Porges, N.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Powell, M. E.	Knudsen Creamery Co.	Los Angeles, Calif.
Quigley, T. W.	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Raymond, R. T.	The Borden Co.	Watertown, N. Y.
Reed, O. E.	4927 - 30th Place, N. W.	Washington, D. C.
Reinholz, E. G.	Dairy Belt Cheese & Butter Co.	Spencer, Wisc.
Reiser, C. L.	Agricultural Marketing Service, USDA	San Francisco, Calif.
Roberts, R. E.	University of Georgia	Athens, Ga.
Roberts, W. M.	North Carolina State College	Raleigh, N. C.
Robinson, W. B.	New York Agric. Expt. Sta.	Geneva, N. Y.
Roe, C. E. (Miss)	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Rojko, A. S.	Agricultural Marketing Service, USDA	Washington, D. C.
Roundy, Z. D.	Armour & Company	Chicago, Ill.
Roux, L. L.	South African Embassy	Washington, D. C.
Rubis, J. A.	Agricultural Marketing Service, USDA	Washington, D. C.
Rudolph, O.	Middletown Milk and Cream Co.	Fort Edward, N. Y.
Rutz, W. D.	Kansas State College	Manhattan, Kansas
Sadler, A. M.	Eastern Util. Res. & Devel. Div.	Beltsville, Md.
Sappington, R.	University of Maryland	College Park, Md.
Schneider, I. S.	University of Sao Paulo	Sao Paulo, Brazil
Schulte, R. F.	Brock-Hall Flavor-Rich Dairy Prod.	Hamden, Conn.
Schultz, H. W.	Oregon State College	Corvallis, Oregon
Schwartz, D. P.	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Seely, D. J.	University of Maryland	College Park, Md.

Name	Organization	Address
Sellars, R. L.	Maplehurst Farms, Inc.	Indianapolis, Ind.
Sills, M.	Agricultural Marketing Service, USDA	Philadelphia, Pa.
Silverman, M. T.	Middletown Milk and Cream Co.	Yonkers, N. Y.
Sive, R.	Robin Cheese Mfrs.(PTY), Ltd.	Johannesburg, South Africa
Small, E.	Agricultural Marketing Service, USDA	Washington, D. C.
Steinke, H. C.	Lakeshire-Marty Company	Plymouth, Wisc.
Steinke, P.	Paul-Lewis Laboratories, Inc.	Milwaukee, Wisc.
Stone, W. K.	Virginia Agric. Expt. Sta.	Blacksburg, Va.
Sulzbacher, W. L.	Eastern Util. Res. & Devel. Div.	Beltsville, Md.
Tamsma, A.	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Thew, H. E.	Madison Milk Producers Assoc.	Madison, Wisc.
Tittsler, R. P.	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Tuckey, S. L.	University of Illinois	Urbana, Ill.
Tuthill, J.	National Dairy Products Co.	Middlebury, Vt.
Vettel, H. E.	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Walter, H. E.	Eastern Util. Res. & Devel. Div.	Beltsville, Md.
Warburton, H. W.	Georgia Agric. Ext. Service	Athens, Ga.
Ward, G. E.	Dawe's Fermentation Products, Inc.	Newaygo, Mich.
Wasserman, A. E.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Watrous, G. H., Jr.	Pennsylvania Agric. Expt. Sta.	University Pk, Pa.
Watts, J.	Lever Brothers Co.	Edgewater, N. J.
Weber, D. P.	Agricultural Marketing Service, USDA	Kansas City, Mo.
Weese, S. J.	West Virginia Agric. Expt. Sta.	Morgantown, W. Va.
Wells, P. A.	Eastern Util. Res. & Devel. Div.	Philadelphia, Pa.
Werren, J. C.	Lucerne Milk Co.	Washington, D. C.
Whitaker, R.	National Dairy Res. Lab., Inc.	Oakdale, L.I., N. Y.
Whitnah, C. H.	Kansas State College	Manhattan, Kansas
Williams, D. H.	Dairy Industries Supply Assoc.	Washington, D. C.
Wilson, H. L.	Kraft Foods Co.	Chicago, Ill.
Wilson, R. H.	Agricultural Marketing Service, USDA	Chicago, Ill.
Windlan, H.	American Cyanamid	Princeton, N. J.
Winfield, C. A.	University of Maryland	College Park, Md.
Winslow, R. L.	W. K. Moseley Laboratory	Indianapolis, Ind.
Wise, W.	Lake to Lake Dairy Cooperative	Kiel, Wisconsin
Wishner, L. A.	University of Maryland	College Park, Md.
Wissinger, I. E.	Agricultural Marketing Service, USDA	Washington, D. C.
Wolk, J.	Eastern Util. Res. & Devel. Div.	Washington, D. C.
Zakariasen, B. M.	Land O'Lakes Creameries	Minneapolis, Minn.
Zausner, S.	Meyer Zausner, Inc.	New Holland, Pa.
Ziegler, R. L.	Ziegler & Son Company	Topeka, Kansas
Zimmermann, A.	Quality Control Lab.	Philadelphia, Pa.
Zuercher, J.	C. E. Zuercher & Co.	Chicago, Ill.